

**PERICARDIOTOMY FOR SUPPURATIVE PERICARDITIS
FOLLOWING PNEUMONIA.**

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OPERATIVE intervention in wounds of the heart and pericardium has become so successful in recent years that it is reasonable to hope that surgery may be employed more frequently and more successfully in non-traumatic suppurative pericarditis. In order to stimulate discussion on this topic we present this report.

In a series of papers by American writers, Roberts,¹ 1897, Porter², 1900, Eliot,³ 1909, and Rhodes,⁴ 1915, there has appeared an exhaustive presentation of the subject of suppurative pericarditis, with a collection of the reported cases of pericardiotomy for suppurative pericarditis. "The cases numbered 86, of which 45 recovered and 41 died, a percentage of 52.3 recoveries against 47.7 deaths. In the complete series the infecting organism is reported in but 21, the pneumococcus was found in 9 cases, staphylococci in 4, streptococci in 2, the colon bacillus in 1, the *Bacillus pyocyanus* in 1, and a 'double coccus' in 1." (Rhodes.)

In connection with the case here presented, a case of pericardiotomy for suppurative pericarditis following pneumonia and empyema, we present synopses of the reports of similar cases. We also revised the detail of the technic of paracentesis pericardii and pericardiotomy.

Case Report.—Patient male; aged forty-seven years; occupation, engineer. Family and past history negative. Patient has been under the care of one of us (Camac) for various illnesses for the last fifteen years. These illnesses had no bearing upon the present attack. On December 24, 1915, at the office of one of us (Camac) patient was seen for a furuncle on the back of the neck, which was opened and dressed. On December 29, the wound was practically healed.

On December 30 the patient was seen at his house, and complained of a slight pain in the lower right axilla, on taking a deep breath. Examination showed a few very fine, almost inaudible crepitant rales at the right base, with somewhat harsh, vesicular breathing. Temperature, 104°. He was flushed and felt ill. Respirations,

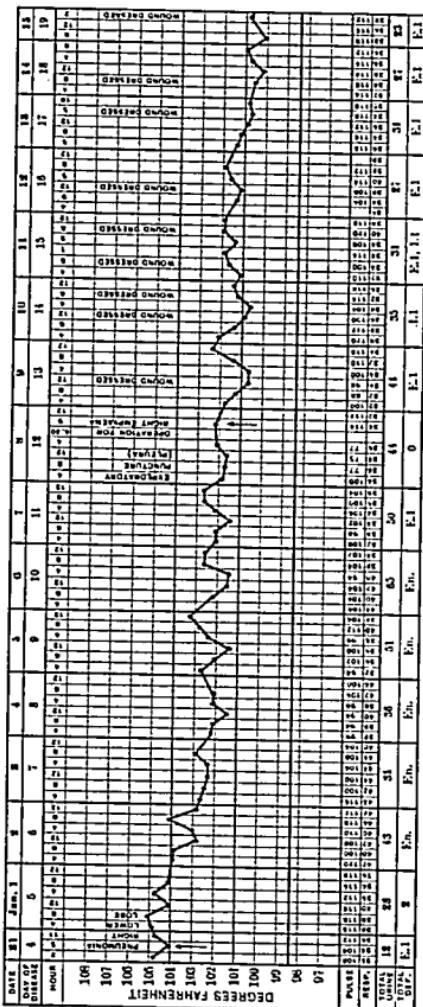
¹ Surgical Treatment of Suppurative Pericarditis, *Tr. Am. Surg. Assn.*, 1897, xv, 101.

² *Ann. Surg.*, 1900, xxxii, 769.

³ *Ibid.*, 1909, xlii, 60.

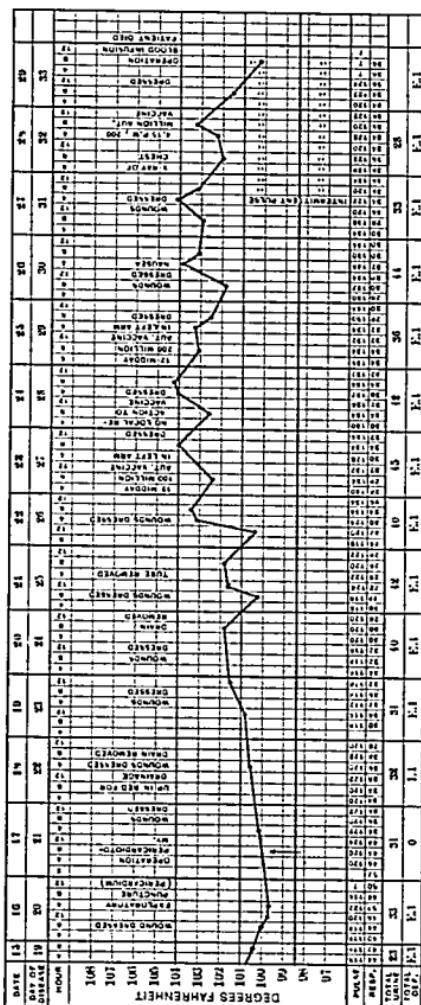
⁴ *Ibid.*, 1915, liii, 660.

34; pulse, 105. He was put to bed and preparations made for possible pneumonia, which on the next day, December 31, gave frank signs at the lower right lobe. The blood count showed



hemoglobin, 85 per cent.; red blood cells, 4,900,000; white blood cells, 10,000. The differential count showed 85 per cent. polymorphonuclears. Urine showed a specific gravity of 1.031, otherwise

negative. The temperature ranged between 104° and 105° for two days, falling to between 102° and 104° on the following two days, remaining at 102°, with one slight rise, for the following four days.



On January 8, the twelfth day of the disease, it was noted that the tubular quality of inspiration and expiration was more intense along a transverse line at the level of the angle of the scapula, with a

diminishing intensity toward the base of the lung. An exploratory puncture on this date revealed a thin, purulent exudate. Thoracotomy and drainage were performed immediately by one of us (Pool). Cultures from this exudate yielded *Staphylococcus pyogenes aureus*, from which vaccines were prepared. Patient did well for the next eight days, temperature gradually falling to 99.3°. On January 10 the following note was made: "Heart action strong and regular, no dropped beats. The rhythm is clock-like, there being no rest periods." On January 11 the following nurse's note: "Respirations labored most of the day. Pulse feeble and intermittent. Breathing better upon loosening dressing." January 15 and 16 showed a distinct change in pulse, somewhat irregular and weaker. On January 16 the color of the skin was noted as bad and the respirations labored. Physical signs suggested pericardial effusion, which was confirmed by exploratory puncture; a thin, purulent exudate being obtained, which on culture (by Dr. Mortimer Warren) revealed the same organism as that found in the pleura. The opening and draining of the pericardium was now considered as offering the only chance of relieving the severe cardiac embarrassment. This was done under local anesthesia by one of us (Pool) by the method described in the discussion below. While the patient's condition was critical during the operation, his color and pulse improved markedly the moment the pericardium was relieved of the purulent effusion. He continued to do well for six days following the operation, the pulse, however, being somewhat irregular and at no time forcible. The respirations occasionally became labored, but were always relieved after dressing the pericardial wound. On January 22 the calf of the right leg became painful and swollen, and it was evident on examination that phlebitis had developed. Blood culture at this time showed *Staphylococcus aureus*. On the evening of the 22d the heart action and breathing became greatly embarrassed, and the following note was made: "Temperature has steadily risen since operation; pulse weak; no heart sounds audible; drainage poor. Digital examination into the wound showed heart sealed to pericardium. Finger introduced deeply in wound, and fresh adhesions broken up, yielding a copious discharge of very thick stringy material and much pus. Patient's condition markedly improved and the heart sound became distinctly audible." On January 23 and 24 respiration and heart action remained good, and the drainage from the pericardium free. On January 26 the pulse became small and intermittent and there was considerable nausea. On January 27 the temperature reached 104.5°, falling to 102° on January 28. On this date the chest was radiographed. The report of the findings is as follows:

Indications of fluid and some air in the right pleural sac, with partial collapse of the lung. The heart shadow is distinctly enlarged, suggesting fluid in the pericardium.

Autogenous vaccines were employed, but it was realized that these were used too late in the disease to markedly influence its course. On January 29 the patient died.

PARACENTESIS PERICARDII AS A DIAGNOSTIC ADJUVANT. Although this procedure exposes to the danger of accidental injury to the heart, coronary artery or vein, pleura, lung or internal mammary artery, it must be emphasized that serious accidents have occurred so infrequently that there should be no hesitancy in performing paracentesis when the operation seems definitely indicated. The limitations of exploratory puncture should be definitely appreciated. Even when fluid is present, puncture has often proved unsuccessful. A dry tap may result from the needle becoming blocked with fibrin or with tissue that has been penetrated during its introduction. Moreover, the exudate, especially early, may lie in such a position as to be out of reach of the needle. If suppurative pericarditis is suspected, diagnostic punctures should not be made repeatedly; when several attempts have been made, puncture should be abandoned in favor of pericardiotomy. It must be stated that a number of writers decry the use of puncture for diagnostic purposes. Rhodes states that it can be of positive danger and is usually superfluous.⁵

Opinions differ widely as to the point of election in paracentesis of the pericardium. The favorite sites for punctures fall into two groups: those which are planned to avoid the pleura and those which disregard the pleura, but which are planned to avoid the heart. Under normal conditions the pleura can be avoided by introducing the needle in the region of the sixth and seventh cartilages of the left side, close to the sternum or below the tip of the xiphoid. On the other hand, cardiac injury is best avoided by puncture at a point situated somewhat internal to the lower part of the left limit of pericardial dulness. Curschman advocates this site in preference to one in the immediate vicinity of the cardiac margin or apex, because the effusion is very frequently associated with an enlarged heart, in which case the heart may extend beyond the apparent position of the apex; moreover, it is at times adherent to parietal pericardi. The disadvantage of the outer site is that the pleural cavity may be entered, a feature which is especially disadvantageous in the presence of suppurative pericarditis, but penetration of the pleural cavity is not a necessary complication, because the pleural edges are separated by the distended pericardium, and not infrequently the pleural layers are agglutinated to a considerable degree by adhesions, causing obliteration of the anterior part of the pleural sac.

The following sites are most suitable for paracentesis of the pericardium:

⁵ Some features in this article are taken, with permission of the publishers, from Johnson's *Operative Therapeusis: Heart and Pericardium*, by E. H. Pool, published by D. Appleton & Co.

1. A point slightly internal to the left limit of dulness, in the fifth or sixth intercostal space.

2. Midline immediately below the xiphoid process. This situation is recommended by François and others as the point of election for entrance, because here the pericardium is reached by the shortest route without injury to bloodvessels, pleura, and peritoneum, while the exudate can be evacuated before the heart is touched. The only contra-indications of this method are extreme malformations of the sternum and a high degree of tympanites. Under local anesthesia a fine trocar or hollow needle of sufficient length is inserted and pushed directly upward to a distance of 2 cm. along the posterior surface of the xiphoid. In this way the peritoneum is avoided, and after passing through the diaphragm the point of the needle is directed upward and backward.

3. A point in the angle formed by the base of the xiphoid process and the seventh left cartilage at its insertion. The choice between these sites must depend upon individual indications.

Pericarditis occurs as a relatively frequent complication in a large number of diseases, the most frequent of which are inflammatory rheumatism, nephritis, pleurisy, pneumonia, pyogenic infections, and tuberculosis, but there are "few infectious diseases which may not implicate the pericardium." (MacPhedran.)⁴

The clinical picture of pericarditis with effusion is variable. Besides the local objective signs, the cardinal sign of exudative pericarditis being a characteristic cardiac dulness which is at first increased upward, there are present to a variable degree, symptoms due to: (1) involvement of the heart muscle (myocarditis), which is the most frequent and serious lesion; (2) endocarditis (these two are especially frequent in association with rheumatism); (3) mechanical disturbance of the heart as a result of pressure exerted by the effusion; this, however, is infrequent; (4) general constitutional disturbances, depending upon the type of the infection, the pericardium offering a large surface for absorption; (5) an associated lesion or disease.

Suppurative pericarditis represents an abscess corresponding to a part or the whole of the pericardial sac. The most frequent organisms are the streptococcus, staphylococcus, and pneumococcus. The exudate is usually purulent from the beginning of the attack, although occasionally it develops in the course of a non-suppurative pericarditis. As a rule, purulent pericarditis is secondary in the course of a pyogenic infection, and under such conditions it frequently constitutes a "terminal infection;" in rare cases suppurative pericarditis is primary; in some cases the infection is introduced through a wound.

Suppurative pericarditis is characterized by the local sign of

⁴ Osler's Modern Medicine, iv, 40.

pericarditis, with effusion and constitutional symptoms of a septic character. The fact that the pericarditis is frequently a secondary lesion causes its presence to be overlooked in many cases. In children the symptoms of pericarditis are particularly apt to be masked. On the other hand, in many cases in which the lesion has been recognized and the pericardium drained, the operation has been unsuccessful because a coexisting purulent focus, especially empyema, has been overlooked. It follows that in septic processes it is necessary to watch for the development of pericarditis; moreover, the recognition of such a condition should not cause less thoroughness in the search for other foci.

The distribution of the fluid in the distended sac must be understood in order to appreciate the technical details of paracentesis or pericardiotomy. First, the recesses become filled, the fluid gathering chiefly in the region of the base of the heart; then the bulging pericardium, confined anteriorly, separates the yielding lungs and pushes the diaphragm downward. The increasing exudate progressively distends the pericardium, for the most part to the left and posteriorly. It must be emphasized that the heart usually, though not invariably, occupies a low position and remains applied to the anterior wall of the thorax. Occasionally an inflammatory process may become localized by the formation of adhesions and the limitation of the exudate to a circumscribed part of the sac.

PERICARDIOTOMY. The methods of pericardiotomy may be divided for convenience into two groups:

1. Procedures which reach the pericardium through the thoracic wall.
2. Procedures which enter from below the costal arch, the epigastric route.

The first method of procedure includes:

Resection of the sixth cartilage, as recommended by Kocher, Axhausen, and Pels-Leusden.

Resection of the fifth cartilage, Gussenbauer and Ollier.

Resection of the fifth and sixth cartilages, Delmore and Mignon.

The second method of procedure has been accorded the preference by Larrey, Mintz, L. Rehn, and Allingham. The approach is in part or entirely from below the costal arch, and is both extra pleural and extraperitoneal.

PERICARDIOTOMY FOR THE EVACUATION OF A PURULENT EXUDATE. In the treatment of suppurative pericarditis the method of pericardiotomy to be efficient must provide for satisfactory drainage, and be sufficiently simple to be rapidly performed under local anesthesia if necessary. Adequate drainage is the essential feature, and upon this must depend, to a large extent, the choice of method. In the interest of good drainage it is important (1) to open the pericardium at its lowest point, and (2) to provide such an opening as will ensure ready egress for accumulation of fluid in both the

right and left spaces of the pericardial sac. Local anesthesia is frequently imperative because the heart is apt to be dilated and insufficient as a result of endocarditis and myocarditis. It is necessary that the work be done with the least possible associated injury. It is not sufficient to avoid wounding the heart; if possible the heart should not be touched. Further, thorough anesthetization of the pericardium is advisable on the basis of significant experimental work, which we will briefly summarize.

Serious disturbances of the heart action have been noted repeatedly to result from irritation of the pericardium. Heitler's⁷ observations on dogs showed that irregularity of the heart follows mechanical or electrical stimulation of the pericardium. D'Agata⁸ (1912) in animal experiments found that a sudden drop in the blood-pressure occurred as a result of grasping and incising the pericardium. These phenomena are presumably reflex in character; they help to explain analogous clinical observations. Thus, Harrigan⁹ reported temporary arrest of the heart upon incision of the pericardium in a case of suppurative pericarditis.

Heitler and D'Agata found in their experiments that preliminary cocainization of the parietal layer of the pericardium prevented the occurrence of irregularity of the heart and the lowering of the blood-pressure. Heitler recommended that before an incision is made in the pericardium it should be anesthetized by means of a 10 per cent. solution of cocaine applied to its surface. Presumably novocain by injection could be substituted to advantage in man.

The two methods most appropriate for drainage in suppurative pericarditis will be described in detail.

1. Resection of the sixth costal cartilage. (Kocher.¹⁰)
2. Resection of the seventh, or sixth and seventh costal cartilages (Rehn.)

Resection of Sixth Cartilage. This method affords adequate drainage at a dependent part of the sac, is simple and quick of execution, may be performed readily under local anesthesia, and the exposure may be extended easily in any direction. It appears the best method for general use and was employed in our case.

With the patient in a semirecumbent position, an incision is made in the course of the sixth cartilage and rib, passing from the midline obliquely outward. The perichondrium is incised in the direction of the wound and separated. The cartilage is then severed close to the sternum and lifted, the perichondrium being separated from its posterior surface. The cartilage is broken at its junction with the rib and removed. The internal mammary artery should be divided between ligatures when exposed. The triangularis sterni is then split. An effort should be made to identify the anterior

⁷ Med. Klin., 1910, vi, 974.

⁸ Arch. f. klin. Chir., 1912, xeviii, 460.

⁹ Ann. Surg., 1913, lvii, 367.

¹⁰ Chirurgische Operationslehre, 1907, xxxiv, 777.

edge of the underlying pleura, which should be pushed outward. The pericardium is thus exposed. It should be grasped and lifted with two pairs of toothed forceps and incised. (The importance of anesthetizing the pericardium has been emphasized above.) The pericardial incision is extended with blunt-pointed scissors. The pus should be allowed to escape slowly. A finger is then introduced to break up adhesions and to evacuate walled-off accumulations of pus. Should the access be too small to allow separation of adhesions, or for adequate drainage, the opening may be enlarged in an appropriate direction by resection of part of the sternum, excision of part of the sixth rib, or removal of the fifth or the seventh costal cartilages. Residual fluid should be removed by aspiration, as in abdominal operations, and sponging or wiping of the serous surfaces should be reduced to a minimum. Clots of fibrin should be extracted with forceps. Irrigation with sterile salt solution has been used for the removal of clots of fibrin, but is not to be recommended. The use of antiseptic fluids is contra-indicated. In closing the wound it is advisable, especially if the pericardium is considerably separated from the sternum, to suture it to the skin. This not only facilitates drainage but "diminishes the risk of contamination of the anterior mediastinum." (Eliot.)

Drainage is favored by the movements of the heart, which in the absence of adhesions tends to force out any accumulated pus (Eliot). The kind of drain which should be used is a detail which demands some discussion. The choice lies between a rubber tube and soft drain. Tubes afford the most satisfactory drainage and may be sutured to the soft parts, so that they are not readily displaced. But if the tube should come into contact with the heart it is likely to interfere with the cardiac action, as occurred in a case operated upon by Riedel.¹¹ Rehn¹² recommends two rubber tubes, one passing to the right side and one to the left to drain both pockets. Eliot, Riedel and others favor soft drains. A general rule cannot be made, as the mode of drainage must be such as to fit the individual case.

Two cigarette drains were employed in our case. They did not drain satisfactorily. We are of the opinion that split soft rubber tubes would have been better.

The sitting position should be enforced in the after-treatment as most favorable for drainage. The wound heals, as a rule, without a persistent sinus, and "after healing is complete, insufficient or irregular heart action is the marked exception; neither is there any indication of cardiac displacement." (Eliot.)

Resection of the Seventh or Sixth and Seventh Costal Cartilages. A curved incision of about 6 cm. is made along the lower margin

¹¹ Zentralbl. f. Chir., 1897, xxiv, 56.

¹² Zur experimentellen Pathologie des Herzbeutels, Arch. f. klin. Chir., 1913, cii, 1; Berl. klin. Wehnschr., 1913, i, 214; Zur Chirurgie des Herzens und des Herzbeutels, Arch. f. klin. Chir., 1907, lxxxiii, 723-778.

of the seventh left cartilage to the base of the ensiform process, across which the incision is continued transversely. The incision is deepened and the seventh costal cartilage divided. The internal mammary artery is preserved. Detaching the soft parts, the finger is passed under the sternum, between the lower portions of the triangularis sterni muscle and the sternal portions of the diaphragm. A piece of the sternum and seventh costal cartilage is removed, followed by resection of the sixth costal cartilage if necessary. The pericardium is readily reached without opening the pleura. The more distended the pericardium the easier the operation. (Description after Kuttner.¹³)

PROGNOSIS. Suppurative pericarditis demands immediate incision and drainage. The prognosis in purulent pericarditis is in general unfavorable, yet in suppurative processes which are confined to the pericardium early operation is quite often followed by recovery; on the other hand, when the pericardium is involved secondarily in the course of a general sepsis, recovery is infrequent. Nevertheless, cases that appear hopeless are occasionally saved by operation. As mentioned below a prognosis must depend largely on the characteristics of the organism causing the disease, but as yet this has not been studied with sufficient accuracy to consider it in this report.

CONCLUSION. The results of pericardiotomy are necessarily modified by the gravity of the fundamental disease, but striking cures have followed operation in apparently hopeless cases of severe infection. In studying our case, together with the literature here quoted, the need for a bacteriological division of these cases seems imperative. From Rufus Cole's work we now have a new aspect of the clinical condition known as pneumonia. This new view-point is bacteriological in character. We now know that the anatomical diagnosis of consolidation of a lobe, or of a purulent accumulation in the pleura or pericardium may be correct, and yet the clinical course vastly different according to the organism producing the condition. In traumatic injuries to the pericardium when operation has been successfully performed and recovery has followed, the favorable factor is probably the absence of bacterial infection. In our case a most virulent organism, the staphylococcus, was the cause of a bacteremia. Was the dose and virulence of the toxin so overwhelming that no known method would have been sufficient to overcome these? Perhaps vaccines should have been used from the time of the furunculosis, but at that time no culture was taken and there was prompt recovery from a single abscess in the neck. The question naturally arises as to whether we should regard these simple abscesses as demanding immediate vaccine treatment as a routine, fearing the development of larger areas of pus in more vital localities.

¹³ Bier-Braun-Kummell, *Chirurg. Operationslehre*, 1912, ii, 55.

Is pericardiotomy justifiable or imperative in all cases of suppurative pericarditis? As to the justification for pericardiotomy in all cases of suppurative pericarditis it would seem that the operation should be performed as an emergency procedure even in desperate cases. The importance of an early diagnosis cannot be too strongly urged. Whether exploratory puncture reveals a purulent or a non-purulent effusion, cultures should be made and an accurate report presented. We may expect that further bacteriological studies will throw light upon the general clinical course due to different types of organisms. Thus the prognosis in a given case may be made more exact and the indications for surgical intervention may be further developed. This case and those quoted from literature go to emphasize the fact now being grasped by the profession that pneumonia is a local manifestation of a systemic infection, and in dealing successfully with it measures capable of reaching the antigen power of the system must be sought and employed.

THE FOLLOWING CASES FROM LITERATURE ARE ARRANGED AS
FOLLOWS:

Suppurative pericarditis following: (1) pneumonia; (a) lobar; (b) broncho. (2) Empyema.

A bacteriological division is not possible, as cases have not been studied accurately with this feature especially considered. This is a most important aspect of suppurative pericarditis and offers a field for future investigation. From the data in some of the following reports it is difficult to determine whether pneumonia was clinically present.

1. Pneumonia: (a) lobar.

Female, aged forty years. Croupous pneumonia, empyema, and purulent pericarditis. Thoracotomy for empyema; six days later pericardiotomy, Ollier's method. Fifth rib resected. Pericardium opened 400 to 450 c.c. of pus with fibrinopurulent exudate evacuated. Drainage tube introduced and held by suture. After operation patient in collapse and cyanotic. Gradual recovery. (Original article not accessible.) (Tallquist; cf. Rhodes.¹⁴)

Boy, aged twelve years. Bilateral diplococcus pneumonia. Ill for about two weeks and was in bad condition before the operation, heart dulness extending two fingers' width beyond the right sternal margin and to the midaxillary line on the left side. Incision along the lower margin of the seventh costal cartilage. A skin and cartilage flap formed which was turned upward, permitting access to the space through which the pericardium could be opened without injuring the pleura; 100 c.c. of seropurulent fluid was evacuated, and a tampon introduced. General condition continued to improve;

¹⁴ Finska Läkarsk. Handl. Helsingfors I, 1912, 575-595.

patient discharged after about two months, with normal heart boundaries and without any disturbance except a fistula from which a small amount of pus escaped. (Mintz.¹³)

Boy, aged five years. Bilateral croupous pneumonia. Apex beat could not be felt; the heart sounds were very faintly audible. Dulness two fingers' width beyond the right sternal margin and a finger's width beyond the nipple-line to the left side. Exploratory puncture in the fifth intercostal space yielded 60 cm. of thick fluid pus, and was followed by visible improvement. Pericardiotomy, with resection of the fifth costal cartilage, according to Ollier. Half liter of pus escaped. The heart was found lying behind and above, floating free in the large cavity. Subperichondral resection of the fourth costal cartilage was added. Drainage with rubber tube the thickness of a thumb. In three weeks cavity had entirely disappeared without leaving a thoracic deformity. Good recovery.

The author emphasizes the advantages of pericardiotomy with costal resection on the basis of Terrier's statistics, and recommends early operative interference, which has a simple technic as in empyema and yields the best results as to life and rapid healing. (Strauss.¹⁴)

Pericarditis secondary to double pneumonia. The pericardium was opened in the midaxillary line and a large amount of pus was evacuated. A few days after the operation there were signs of pus farther back, and an incision there revealed an empyema. The patient died. (Blake.¹⁵)

Boy, aged nine years. Left-sided pneumonia. On the ninth day dulness was noted, extending on the right side one finger's breadth beyond the right sternal margin; on the left side two fingers' width beyond the left maxillary line. Heart sounds inaudible; superficial veins of thorax much distended, especially on right toward shoulder. Pericardiotomy was performed by v. Eiselberg, in spite of the patient's apparently moribund condition. Resection of fifth costal cartilage. Exploratory puncture of bulging pericardial sac yielded pus. Transverse incision of pericardium; escape of about one liter of thick yellow pus. Two rubber drainage tubes. Pulse was plainly palpable three hours after operation. General condition rapidly improved. A fistula persisted for nine weeks. Recovery. Bacteriological examination of the pus showed streptococci. The patient was reexamined nine years after operation and was found to be in good condition. (Walzel.¹⁶)

Man, aged thirty-one years. Pneumonia chiefly involving the

¹³ Chirurgia, April, 1912, vol. xxxi (Russian); Centralblatt f. Chir., 1912, No. 30, p. 1046.

¹⁴ Nuremberg Med. Soc., meeting of July 15, 1909; München. med. Wehnschr., 1909, No. 39, p. 2039 (or 7).

¹⁵ New York Surgical Society, October 25, 1908; Annals of Surgery, 1909, xlix, 142.

¹⁶ Mittg. a. d. Grenzgeb. d. Med. u. Chir., 1913, xxv, 264.

left lung. Three weeks later cardiac dulness four fingers' breadth to the right of the sternum, with muffled heart sounds, persistent high temperature, considerable cyanosis, and dyspnea. Pericardium was incised, after removal of the seventh costal cartilage and a portion of the sixth; 3 to 4 ounces of fluid were withdrawn. Numerous adhesions between the right heart and parietal pericardium were broken down and a tube was inserted, which was removed on the sixth day after the operation. The patient made a good recovery. (Pandlebury; cf. Eliot.¹⁹)

Male, aged thirty-six years. Bilateral pneumonia. On the thirteenth day the pericardium was considered involved. Twenty-first day the cardiac dulness was decidedly increased in all directions, especially toward the right. Exploratory puncture yielded a turbid greenish fluid. On culture a pure growth of pneumococci. Incision of pericardium and evacuation of about a pint of pus. Examination showed pneumococci. Drainage tube removed twenty-six days after operation and the patient left the hospital fifty-one days after operation, free from physical signs of an adhesive pericarditis. (Scott; Eliot.²⁰)

Woman, aged thirty-eight years. Puerperal sepsis and double pneumonia, three weeks before admission to the hospital. Extensive area of cardiac dulness, the heart sounds being almost inaudible. Puncture of the pericardium in the fourth intercostal space yielded pus. Excision of the fourth left costal cartilage with evacuation of 20 ounces of grayish-yellow pus. Drainage, with profuse discharge, until death one week after the operation, probably due to suppurative peritonitis.

Examination of the pus from the pericardium showed various streptococci and staphylococci. (Hall; Eliot.²¹)

Patient, aged two and a half years. Pneumonia a month before admission to the hospital, when the diagnosis was made of a probable empyema at the right base, with a purulent pericarditis. Chloroform anesthesia. Oblique incision exposing the fifth left cartilage, which was removed in part with adjacent part of sternum. Incision of the pericardium with evacuation of about half a pint of thin greenish-yellow pus under pressure. A rubber drainage tube was inserted. Pericardial fluid contained a coccus which resembled pneumococcus. Temporary improvement. The empyema pus, obtained by operation on next day, showed a coccus which resembled the pneumococcus; other forms of cocci and bacilli were also numerous. The patient died in the sixteenth week after the operations.

Necropsy. On opening the thorax there was found a condition of universal dense adhesion of the contained viscera to each other and

¹⁹ Lancet, October 22, 1904, p. 1144.

²⁰ New York Med. Jour., January 30, 1904, p. 198.

²¹ Lancet, 1903, ii, 951.

to the chest wall, and the whole anterior mediastinum was occupied by a thick fibrogelatinous deposit. The wound over the pericardial area drained a small pocket on the anterior surface of the heart, but elsewhere the pericardium was inseparably adherent to the heart in front. On attempting to separate the pericardium from the left lung an abscess cavity was opened, with a discharge of 3 ounces of pale thick pus. This cavity lay behind, and to the left of the heart and within the pericardial sac; its walls were very thick from the presence of fibrinous matter similar to that occupying the mediastinum. Between the heart and the right lung there lay another smaller cavity, independent of the first, and full of inspissated pus. The pus in both cavities was dry and gritty to the feel, as if impregnated with lime salts. The tracheal glands were greatly enlarged, but free from all sign of tubercle. The pleurae were everywhere adherent. (Coutts and Rowland; Eliot²¹.)

Boy, aged sixteen years; sore throat, followed a day or two later by most of the symptoms of pneumonia of the left base without very distinct physical signs. At the end of three weeks, a left empyema was opened, without much relief to the general symptoms. Ten days afterward, the pericardium was opened, with only slight temporary general improvement. Death thirteen days after incision of pericardium, apparently due to external hemorrhage from the heart through rupture of a small parietal abscess.

Bacteriological examination proved the presence of pneumococci in great numbers in the blood, death being the result of a general pneumococcus pyemia. (Sibley, Arbuthnot Land and Rowell; Eliot.²²)

Pericarditis developed after a severe (left-sided) pneumonia. Aspiration showed the presence of a purulent effusion. Thirty ounces of the fluid were removed by aspiration. Pericardiotomy under local anesthesia, nearly 40 ounces evacuated. The pleura was slightly incised at the operation, and probably became infected, although it was at once carefully closed. The patient's condition at once improved and the alarming acute symptoms disappeared. The right pleura extended beyond the sternum, owing to the compensatory hypertrophy of the right lung, because of the pneumonia in the left. The accidental incision of pleura probably followed by infection. Patient died of purulent pneumonia a few days later. (Connor, L. A.; operator, Stimson.²³)

Male, aged fifteen years. Severe double lobar pneumonia. Pericardial friction sound heard on the fourteenth day. No increase of heart dulness could be demonstrated for two days, however. Ten days later the patient was in very bad condition and was aspir-

²¹ Brit. Med. Jour., 1904, i, 9.

²² Ibid., May 23, 1903, p. 1192.

²³ Med. News, January 20, 1900, lxxvi, 115; New York Academy of Medicine, stated meeting, December 19, 1899.

ated for the pericarditis, with removal of $18\frac{1}{2}$ ounces of pus. This was found to contain a pure culture of the pneumococcus. No improvement. Operation under local anesthesia, incision from third to fifth intercostal space; resection of three-quarters of an inch of the costal cartilages. Penetration of pericardium was at once followed by a tremendous gush of pus, estimated at 50 to 60 ounces. Wound was left open; no artificial drainage. Irrigations with normal salt solution. Patient in excellent general condition three months after the operation. Bacteriological examination showed pneumococcus in pus in pure culture; pneumococcus and streptococcus in sputum. (Lilenthal, H.²³)

Male, aged twenty-four years. Lobar pneumonia. Sudden attack of chills and fever; followed by dyspnea and pain in left half of chest. Exploratory puncture. Incision in middle of fifth intercostal space, between sternum and nipple. Incision showed the existence of pleural adhesions. The pericardium was opened, and a large stream of pus spurted out. Patient was in collapse, but recovered after digital massage of the heart. The fluid had a greenish color, contained some fibrin flakes, and amounted to about $1\frac{1}{2}$ liters. A thick long drainage tube was inserted, reaching to the back portion of the pericardium. After a fortnight, careful irrigations of the pericardial cavity with salt solution were begun and repeated every third day, to wash away the fibrin coagula, but it finally became necessary to do a resection of the fifth rib, in order to obtain a freer access to the pericardium and break up adhesions. After this, recovery was rapid; fistula closed a month later. Patient discharged in good condition, about five months after admission to the hospital.

No bacteriological growth from original fluid; microscope showed small, short bacilli often lying two or three together. *Bacillus pyocyaneus* grew in all cultures made from the discharge after operation. (Ljunggren, C. A.²⁴)

Male, aged twenty-two years. Acute pneumonia. Pericardiocentesis; incision in fourth left interspace, under cocaine. Forty-five ounces of pus escaped. Irrigation with boracic acid. Tube drain. Temporary improvement was followed by purulent effusion in both pleural cavities. Bilateral costal resection and escape of 35 ounces of pus. Pneumococci were present in the pus from both pleural cavities. The pus from the pericardium showed almost a pure culture of pneumococci. Death one month after admission to the hospital. (Sevestre, R.²⁵)

Male, aged twenty-two years. Purulent pericarditis due to pneumonia. No pericardial friction. Double empyema. Aspiration fourth space one inch from sternum; incision in same place. Evacu-

²³ Med. News, 1899, lxxv, 697. Presentation of case, New York Academy of Medicine, Section on Surgery, November 13, 1899.

²⁴ Nord. Med. Arkiv., 1898, ix, 1.

²⁵ Lancet, April 23, 1898, i, 1109.

ation of large amount of pus. Death eighteen days after operation. Autopsy findings: Thickened pericardium; double empyema. (Bradbury, quoted by Sevestre.²⁵)

Boy, aged fourteen years. Pleuritis, pneumonia. Abscess of thigh, acute arthritis of left shoulder. There was much dyspnea and some cyanosis, and there were physical signs of pneumonia of the base. The left pleura was tapped, but only a few ounces of serum were evacuated; from the pericardium 24 ounces of pus was drawn off. Though relieved for a time the dyspnea and cyanosis returned, and the patient died. (West, S.²⁶)

Boy, aged six years. Pyemia and septic pneumonia after necrosis of metatarsus. Pus having been shown by aspiration, the fifth interspace was incised and 8 ounces of pus evacuated, no irrigation. Drainage tube of 3½ inches. Temporary relief, but rise of temperature on next day (104° F.). Patient lived seven days after the operation. (Davidson, P.²⁷)

The author says that this case resembles Bronner's observation in several points, viz., in the occurrence together of pleurisy, pneumonia, and pyopericarditis, also in the character of the pneumonia, sometimes called "wandering pneumonia;" and in the rise of temperature after the opening of the pericardium.

Boy, aged six and three-quarter years. Admitted with history of a fortnight's illness, with cough, fever and pain in the left side. Pus was obtained on exploratory puncture in left pleural cavity. Next day, thoracotomy and removal of 10 ounces of pus. Drainage. Increasing precordial dulness. Exploration of pericardium yielded pus. Incision in fourth interspace; escape of several ounces of creamy pus. Tube drain. Pericardium and empyema took about five weeks to heal. Patient was discharged in good condition two months after admission.

Girl, aged eleven years. Influenza, pneumonia, and empyema. Thoracotomy of right pleura pericardiotomy. Incision in fourth space one inch from sternum; escape of 2 pints of thick pus. Irrigation: short tube drain. Pericardial cavity was syringed out on eleventh day after operation. Death twenty-six days after the incision into the pericardium, on the sixtieth day of illness. No bacteriological examination of pus. Bronner says that the pneumonia resembled Ribbert's streptococcus pneumonia, characterized by great irregularity of the percutory and auscultatory symptoms, by a tendency to spread, and by irregular infiltration of the lung tissue on postmortem examination. (Bronner; operator, Teale.²⁸)

Female, aged twenty-two years. Right-sided pneumonia and right empyema pericardiocentesis. Seven days later pericardio-

²⁵ Lancet, 1898, i, 1111.

²⁶ Brit. Med. Jour., December 8, 1883, p. 1129; February 21, 1891, p. 404.

²⁷ Ibid., March 14, 1891, p. 578.

²⁸ Ibid., February 14, 1891, p. 350.

tomy; incision in third space near sternum. Escape of large amount of purulent fluid. Drainage. No irrigation. Left empyema after operation. Death (pyemia) on thirteenth day after pericardiotomy. Bacteriological findings: Bacilli in pus, small short ends, neither pneumococci nor streptococci. Autopsy findings showed pus in pericardial and both pleural cavities, as well as acute nephritic changes. (Sievers, R.²²)

Male, aged twenty years. Right lobar pneumonia; pleural and pericardial effusion. Aspiration. Incision in fourth intercostal space, between nipple and sternum, on thirty-fourth day. No irrigation. Tube drain, free outflow of pus. Death from heart failure in thirty days, after pericardiotomy, and sixty-fourth day of illness. Bacteriological findings: Fraenkel's diplococcus in pus discharged from wound. (O'Carroll, J.²³)

Male, aged thirty-three years. Influenza pleuropneumonia followed by purulent pericarditis. Tapped three times. Incision in third intercostal space; pus under high pressure escaped on incision of pericardium. Local anesthesia (Schleich). Irrigation, boric acid, gauze drain. Immediate relief and improvement. Recovery in four and a half weeks. Discharged from hospital three months after the pericardiotomy. No bacteriological examination of pus. (Bohn, H.²⁴)

Male, aged twenty-six years. Pneumonia. Pericardial effusion. Left empyema. Pericardiocentesis; incision in fifth left space $1\frac{1}{2}$ inches to left of sternum. Large amount of pus evacuated. Irrigation with salt solution. Drainage with two tubes. Resection of fifth rib, six days later, for better drainage. Empyema; pneumothorax after operation. Recovery. Bacteriological findings: Pneumococcus in pus from pericardium and empyema. (Shattuck, F. C.; operator, Porter, C. B.²⁵)

Girl, aged twelve years. Influenza and pleuropneumonia. Paracentesis of pericardium. Resection of fifth and sixth ribs; pleura opened and sutured after evacuation of some bloody serum. Irrigation with boric acid solution; drainage, two large tubes. Recovery in six weeks. No bacteriological examination of pus. (Björkman; quoted by Roberts.²⁶)

(b) Broncho:

Boy, aged ten years. Twelve days before admission he fell forcibly upon the left anterior part of his chest. Three days later felt sick and complained of pain in the left side.

Examination. Fever, cough, dyspnea. Temperature, 39°; pulse, 130; respirations, 36; rather diaphragmatic, and left side of thorax

²² Ztschr. f. klin. Med., 1893, xxii, 26.

²³ Dublin Jour. Med. Sc., 1896, cit, 11; Same case as that of O'Carroll in Tr. Royal Acad. Med., Ireland, 1896, xiv, 106.

²⁴ Deutsche med. Wehnschr., 1896, xxii, No. 48, 769.

²⁵ Boston Med. and Surg. Jour., 1897, cxvi, 438.

²⁶ Am. Jour. Med. Sc., 1897, cxiv, 662.

remaining immobile in respiration. Dulness on left from clavicle embracing, below, the precordial area, and extending one finger's breadth beyond right sternal line. On the left the dulness continues to axillary line. Signs of fluid in left pleura. Bronchopneumonia and congestion.

Diagnosis. Pleuropericarditis. Aspiration in seventh space, axillary line. No result. Condition gradually worse, with abdominal and precordial pain, loss of sleep from pain and cough. Streptococci in expectoration. Nine days after entrance into hospital an aspiration through fifth left intercostal space in mammary line; pus withdrawn. Operation. Incision 4 cm. long in fifth intercostal space, commencing 1 cm. from left sternal margin. Down to pericardium. Aspirated 250 grams of pus. Cultures showed white colonies, Gram-positive. Rapid fall in temperature.

Patient had a stormy time with the bronchopneumonia, but left the hospital with normal heart outlines and good action. No retraction of intercostal spaces. (Björkman; Imerwol; cf. Rhodes.²⁷)

Boy, aged eight years. Admitted as a case of appendicitis. Tentative diagnosis was bronchopneumonia, affecting principally the left lung, with possible pericardial effusion. Three days later pericardial paracentesis; 6½ ounces of thick purulent fluid withdrawn, giving almost immediate relief. Two days later pericardiotomy, after resection of part of fifth rib about 1½ pints of pus evacuated. Drainage tube inserted; discharge free. After first gaining some strength, the patient slowly lost ground, under symptoms of pyemia. Death. Examinations of the purulent discharge showed a double coccus (thought not to be pneumococcus by laboratory interne). Examination of the sputum for tubercle bacilli and pneumococci was made with negative results. According to the postmortem report, the left lung was totally collapsed and compressed to a very small size into the apex of the left chest. In the base of the right lung there was a cavity about the size of a walnut, containing bloody purulent fluid. No communication between the pericardium and lungs or pleura. The collapsed left lung was explained by the fact that the pleura was probably accidentally opened during the operation. (Gengenbach, F. P.; cf. Eliot.²⁸)

Boy, aged four years. Severe bronchopneumonia. Pericardiotomy. Resection of fifth cartilage; pleura not opened. Seropurulent fluid and typical pus from deepest part of sac, about 10 ounces. No irrigation; gauze drain. Death in three days. There was no evidence of, and no history to suggest that the whole condition was pyemia. The pus from the pericardium gave on cultivation an almost pure growth of Friedländer's pneumococcus. (Robinson, H. B.; Case II.²⁹)

²⁷ Hygeia, 1896, lviii, 189; Am. Surg., 1915, lxii, 660.

²⁸ Colorado Med., 1906, iii, 198. (A case of purulent pericarditis.)

²⁹ Brit. Med. Jour., November 26, 1898, ii, 1605.

2. Empyema.

Male, aged twenty-eight years. About January 7, 1913, when working, he developed pain in the right side, shortness of breath, cough, and tenacious sputum, and came to hospital for treatment. Temperature, 102.4°; right lower lobe dull. Crepitant rales and bronchial breathing.

January 14, complained of pain in right side, also pain in precordial region. Pericardial friction rub heard.

January 31, needle introduced in sixth interspace just beyond apex of heart and a quart of pus drawn off.

Operation. Ransohoff. Local anesthesia (cocain). Sixth rib, 2 inches or rib resected, starting one-half inch from sternum. Pericardium punctured and pus drawn off. Pericardium opened liberating about 3 pints of a fairly thick yellowish pus. Pericardium stitched to thoracic wall and gutta-percha drain inserted.

March 5, patient died.

Autopsy. Right lung showed congestion and an infarct in lower portion of middle lobe; pleura normal. Left pleural cavity contained about a quart of greenish pus, and the lung was found compressed into upper part of pleural cavity. It showed infarction and congestion.

Pericardial sac was entirely obliterated except posteriorly below and anteriorly where drainage had been established.

Pancreas, spleen and alimentary canal normal.

Left kidney showed a total infarction due to thrombosis of renal artery. Right kidney was congested. (Ransohoff; cf. Rhodes.⁴⁰)

Boy, aged nine years. Two weeks before admission had chills and fever, pain in left side of thorax, fever high.

Diagnosis. Exudative pericarditis and pleurisy.

May 5, aspiration in axillary region, fifth interspace, gave pus from left plura.

May 6, aspiration in anterior axillary line, fifth left interspace 300 grams, seropurulent fluid. Aspiration of pericardium, fifth left interspace 3½ cm. from left sternal border gave pus. Improvement.

May 19, thoracotomy in fifth left space, axillary line; 350 grams of pus, drainage tube.

May 20, discovered that the pericardium opens into the left pleura by an orifice. Heart sounds audible and apex beat visible. For the next four days this orifice increased in size. Case gradually improved and discharge lessened. Drains removed July 15 and gauze substituted. Wound cicatrized.

July 20, no retraction of intercostal spaces. Normal. Pus showed pneumococci. Imerwol, V.; cf. Rhodes.⁴¹)

Girl, aged six years. Empyema; thoracotomy. Pericardiotomy. Incision one-half inch within and above apex beat. Nine ounces of pus removed. No irrigation; tube drain. First improvement; two weeks later aggravation of condition in spite of good drainage.

⁴⁰ Ann. Surg., 1915, lxii, 660.

⁴¹ Ibid., lxiii, 660.

Incision was now made in the eighth interspace at the post-axillary line, 16 ounces of pus were removed, and a tube was inserted. Resection of a portion of three ribs was done later. The patient died within a week after the last operation. In the light of post-mortem knowledge it appears that this case was a primary mediastinopericarditis, which within two months was followed by a purulent pleurisy. It would seem that the child presented a primary inflammation of the entire anterior mediastinum, which included the pericardium; the empyema was concomitant through continuity. (Edwards, W. A.⁴)

Patient was a soldier with left-sided pleurisy following influenza. Empyema. Incision in sixth intercostal space; demonstration of general pleurisy, with considerable retraction of the lung. General improvement followed, but dyspnea persisted and became greatly aggravated three days after the operation. Paracentesis. Pericardiotomy. Incision 6 cm. in fourth intercostal space; escape of only a few drops of turbid fluid. Patient succumbed to asphyxia a few minutes later; the operation having been too long delayed.

Autopsy findings showed that anterior wall of heart was adherent, about a pint of pus was found behind and at the sides of the adherent heart. (Delorme and Mignon.⁵)

Boy, aged seven years. Pericarditis, followed by empyema. Pericardium was reached through left fourth interspace, and a considerable quantity of seropurulent fluid. Drainage tube. Considerable improvement. The fluid removed was albuminous and coagulable, and contained *Staphylococcus pyogenes aureus*. Empyema subsequently developed, fluid aspirated contained the *Staphylococcus pyogenes aureus*. Thoracotomy yielded 30 ounces of pus. Good recovery. (Peters, G. A.⁶)

Male, aged thirty-six years. Old purulent encysted pleurisy, no acute course. Resection of two inches of fifth cartilage; pleura not opened; incision of pericardium; escape of 15 to 16 ounces of pus. Irrigation with hot water; edges of pericardium were sewed to skin.

Death from weakness in fourteen hours. According to the post-mortem findings the origin of the pericardium appeared to be a collection of pus lying close to the right of the sac between it and the lung and the chest wall, which was the result of a previous pleurisy. (Ogle, C., and Allingham, H.⁷)

Boy, aged eleven years. Old empyema. Resection of the sixth rib below and inside nipple. Evacuation of 2 quarts of pus. Irrigation with sterile water, gauze drain. Death in twenty days. Allen; quoted by Roberts.⁸)

⁴ Transactions of the Medical Society of the State of California, 1893, p. 166.

⁵ Rev. de Chir., 1895, xv, 100S.

⁶ Edinburgh Med. Jour., 1903, xiii, 209. Purulent pericarditis complicated by empyema; operation and recovery.

⁷ Lancet, March 10, 1900, i, 693.

⁸ AM. JOUR. MED. SC., 1897, cxiv, 662.